TITLE: TEST PROCEDURE FOR DYNAMIC COMPACTION OF BENTONITE

Revision 0

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TEST PROCEDURE FOR DYNAMIC COMPACTION OF BENTONITE

1. OBJECTIVES AND OUTLINE OF PROCEDURE

The objective of this test is to determine the compaction properties of bentonite achieved at the specified conditions, such as total compaction energy, water content, water chemistry, mold size, rammer size and shape. The testing consists of applying a fixed number of blows on the top surface of bentonite placed in a mold in layers, using a rammer with specified size and weight, and dropping freely from a certain height. The density of the compacted bentonite is calculated, and the compaction achieved is estimated assuming 2.5 g/cm^3 or the value specified in the material specification from the bentonite manufacturer.

2. QUALITY ASSURANCE

All testing activities will comply with the SNL WIPP quality assurance program, and will be documented in scientific notebooks and on the test report form included in the Appendix. Results of testing as documented in notebooks shall be reviewed by the UNR PI or designee (Dated and initialed).

3. RECORDS

All documentation developed during the testing activities should be identified as a QA record and submitted to the SNL principal investigator or designee for review and submitted to the record center (e.g., Test Report Forms, calibration records, copies of notebook pages).

4. CALIBRATION

The balance used to weigh samples and the compact compression machine should have a valid calibration. Standard weights should be used for accuracy checking (see WIPP Procedure 162) daily when the balance is used. Record S/N's of scale, pressure gages, and transducers and standards, plus results of the checks in the scientific notebooks.

5. APPARATUS

1). Standard mold assembly of 4" (10 cm), 6" (15.3 cm) diameter (ASTM D1557-91), or a 12" non-standard mold.

2). Rammers or weights with guide sleeve (5.5, 10, 20, 30, 50, 75 lbs. 18" drop height).

(Note: subject to change according to needs).

3). Mechanical compactor, or Lift equipment, electronic magnet and controller (if needed).

4). Electronic Balance, resolution to 0.5 g or better.

5). Checking weights

6). Straightedge

7). Mixing tools (pan, spoon, trowel, spatula, spray bottle and steel rod).

8). Jars with air-tight cap

6. MATERIAL

1) Commercial grade bentonite, granular, powder;

2) Distilled deionized water, or WIPP or other brine.

7. TEST PROCEDURE

7.1 Sample preparation

1. Weigh out an appropriate amount (W) of air-dried bentonite (with predetermined water content W_i) to the nearest 1 g.

2. Determine the weight of water (W_{add}) to be added to the bentonite to render a desired water content (W_c) . This weight can be calculated using the following formula:

$$W_{add} = W\left(\frac{100 - W_i}{100}\right)\left(\frac{Wc - W_i}{100}\right) \qquad (1)$$

3. Add a small amount of distilled deionized water or brine to the bentonite and mix thoroughly. Use a plant sprayer to distribute the distilled deionized water evenly across the sample. Repeat this process several times until the water added reaches the prescribed amount.

4. Transfer the sample into a plastic jar with an air-tight cap (one jar per compaction layer). Let the sample cure for at least 72 hours before starting compaction.

7.2 Compaction

Note: Follow ASTM D1557-91 as closely as possible, except for the following:

1. Thoroughly clean the mold assembly and weigh without collar. Fix collar and keep the assembly ready for receiving bentonite.
2. Place sample from the air-tight jar into the mold and level.
3. Apply a particular compactive effort or number of blows to the sample in the mold assembly. Rammer axis should be perpendicular to the surface of the sample. Rammer should free drop to the sample.

4. Distribute the blows uniformly over the surface of the leveled bentonite specimen. Follow the sequence shown in Figure 1 (a) for the first four blows, if using a 4" mold, otherwise follow Figure 2 (a). Move the rammer progressively around the edge of the mold between successive blows, as shown in Figure 1 (b) if you use a 4" mold, otherwise follow Figure 2 (b).

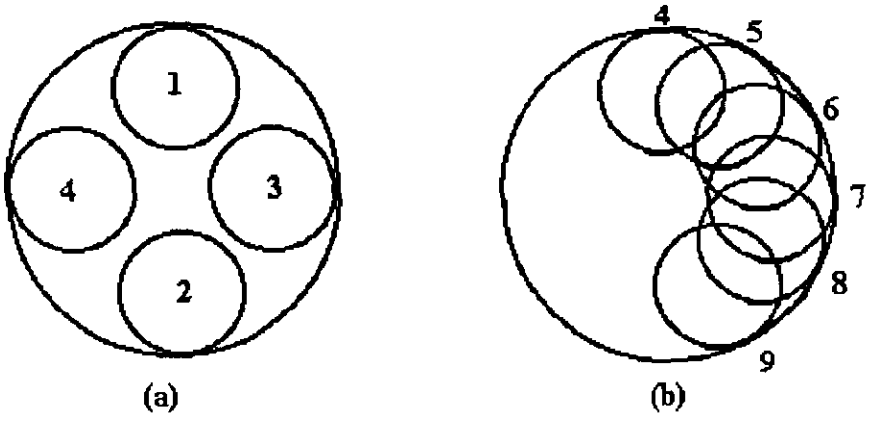

Figure 1. Sequence of blows using hand rammer and a 4" mold

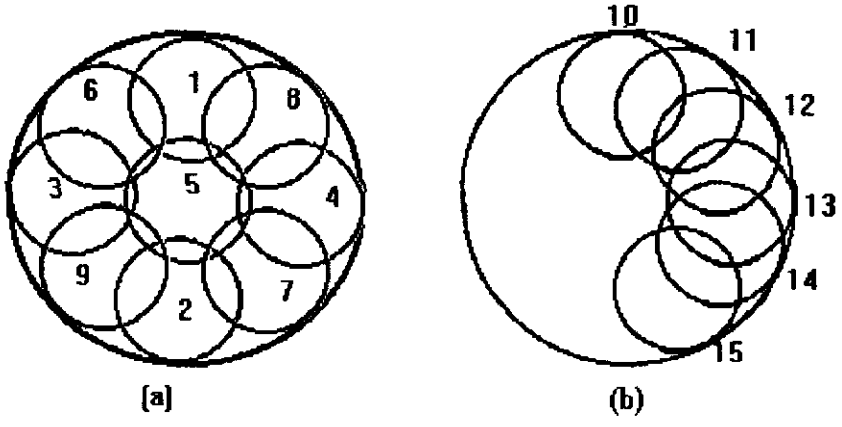

Figure 2. Sequence of blows using hand rammer and a 6" or larger mold .

5. Check the nuts, tighten the loose one(s) if any.
6. Repeat steps 2 through 5 for the 2nd, 3rd, 4th, and 5th layers. Each layer should be approximately equal in thickness or be specified by the PI or designee.
7. Following compaction of the last layer, remove the collar and trim the top surface of the compacted bentonite with the straight edge to get a visually smooth surface.
8. Determine and record the mass of compacted bentonite with mold and calculate the weight of the compacted bentonite alone to the nearest gram.
9. Determine the gas or brine permeability of the compacted bentonite specimen as required.
10. Remove the bentonite from mold, slice it, to determining the moisture content and density of each layer according to needs. Store the sample in a labeled (with date and test number) plastic bag.

Note: Determining the gas permeability, moisture content and density of each layer of he compacted bentonite are optional.

11. Clean the mold and rammer assembly, the straight edge, sieves and mixing tools very well.

8. CALCULATION

Subtract the added percentage weight of water from weight of compacted bentonite to get the dry weight. From the dry weight of compacted bentonite and volume of the mold, calculate the density of the compacted specimen. Calculate the percentage compaction achieved by comparing with specific gravity of bentonite 2.5 g/cm^3 (156 lb/ft^3) for Volclay GPG 30 or the value specified by the bentonite manufacture. Report the findings in laboratory notebook and in the test report form in the Appendix.

9. REFERENCES

ASTM D1557-91, "Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))," *Annual Book of ASTM Standards*, Construction, Vol. 04.08, American Society for Testing and Materials, Philadelphia.

APPENDIX

Test Report Form: Dynamic Compaction of Bentonite

Job: SNL Contract # AG-4915 Test Series No:_____
Test No:_____ Sample:_____
Tested by:_____ Test Date:_____
Compaction method:_____ No. of layers (L):_____
No. of blows/layer (B):_____ Rammer weight (R):_____ lb. _____ kN
Drop height (D): _____ ft _____ m Compacted volume (V):
Compaction energy (LBRD/V):_____ ft-lbf/ft^3 _____ kN-m/m^3

Mold details

Mold inner diameter (d): _____ in

Sample height (H_M): _____ in

Empty weight of the mold (W_M) = _____ g

Volume of the compacted bentonite, V

Volume of compacted bentonite (V): = $(\frac{\pi d^2 H_M}{\times 12^3})$ ft^3 = _____ ft^3

= $(\frac{\pi d^2 H_M}{\times 39.37^3})$ m^3 = _____ m^3

Water content and weight of wet compacted bentonite, W_w

Weight of dry sample used (W_D): _____ g

Weight of water added (w_w): _____ g

% water content (w) = (w_w/W_D) x 100 = _____ %

Weight of mold + weight of wet compacted bentonite (W_{MW}): _____ g

Weight of wet compacted bentonite (W_w): = (W_{Mw}-W_M) ÷ 1000 = _____ kg

= (W_{Mw}-W_M) ÷ 453.6 = _____ lb

Density

Wet Density (ρ_w) = (W_w/V) = _____ kg/m^3

$= \_\_\_\_\_ lb/ft^3$

Dry Density (ρ_d) $= \rho_w/[1+(w/100)] = \_\_\_\_\_ kg/m^3$

$= \_\_\_\_\_ lb/ft^3$

Results:

% compaction achieved (P) = $(\rho_d/\rho_{dmax}) \times 100 = \_\_\_\_\_$

[ρ_{dmax} = kg/m^3 (lb/ft^3) = density of bentonite particles]

Observation/Comments: